MUSCULAR TISSUES IN HYDROIDS POLYPES.

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Plate XXX.

The muscular tissue of the Cœlenterata is produced like that of all Metozoa from the two germinal layers of the gastrula embryo. In some of the orders this process is carried out direct; the muscles are epithelial. In others the muscles are produced from the Mesoderm, and therefore do not appear epithelial. The Hydromedusæ, Syphonophora, Schyphomedusæ, and Antozoa belong to the first group. The muscular fibres at first appear as processes of the centripetal part of the epithelial cells (1), with higher development division of labour occurs; some of the epithelcells lose whilst others retain the locomotory function. At the same time the muscular cells retreat from the surface, which is finally exclusively formed by the non-muscular covering cells. The muscular cells and their fibres form a layer between the Mesoderm (Stüzlamelle) and the covering Epithelium (2.) The shape of the muscular lamella obviously depends on the shape of the supporting membrane. As long as the latter remains simple and unfolded, the muscular lamella cannot attain a higher degree of development. This is, however, achieved in many cases in the following manner: —The supporting lamella forms longitudinal ridges, and in this

(1) *N. Kleinenberg.* Hydra, Leipzig, 1872. Seite 15.

(2) *O. und R. Hertwig.* Die Actinien. Jenaische Zeitschrift. Band XIV., Seite 47.

manner the surface is increased. The muscular lamella occupies the sides of these ridges, and so there are many more fibres to the same surface; the muscle is higher developed and stronger. Such structures have been found in the Medusæ (1) belonging to the Hydromedusæ, in the Syphonophora (2) in the Scyphomedusæ (3), and in the Anthozoa Actiniaria (4), and Pennatulidæ (5.)

At first the muscular lamella covers the whole surface of the folded supporting lamella, but with higher development the ridges of the supporting lamella become very narrow, and the muscles lie only on their sides. The exterior margins of this lamella are continued into processes which are the stalks of the epithelial cells (6.) The centrifugal parts of this lamella may coalesce, and so an apparently Mesodermal muscle is produced. Such structures have been observed in the ring-muscle of the Actiniæ by Hertwig (7), and in the marginal tentacle of Charybdea by Claus (8.) No complication of the muscular tissue which could be compared to the

(1) *O. und R. Hertwig.* Der Organismus der Medusen. Jena. 1878, Seite 8.

(2) *C. Claus* Uber Halistemma tergestinum. Arbeiten aus dem Zoologischen Institute, Wien, 1878. Seite 7.

(3) *Von Lendenfeld.* Uber Ccalenteraten der Südsee, Cyanea Annaskala. Zeitschrift für wissenschaftliche Zoologie. Band XXXVII., Seite 511-526.

E. Haeckel. Monographie der Medusen, Zweiter Theil. Jena., 1881, Seite 147.

(4) *Von Lendenfeld.* Zur Histologie der Actinien. Zoologischer Anzeiger, Band VI., Seite 189.

O. und R. Hertwig. Die Actinien. Jenaische Zeitschrift, Band XIII., Seite 567, and elsewhere.

Von Heider. Cerianthus membranaceus Haime. Sitzungsberichte der K. Academie der Wissenschaften in Wien. Band LXXIX., Seite 27, and elsewhere.

(5) *A. Kölliker.* Die Pennatuliden. Abhandl. d. Senkenb. Naturf. Gesellschaft. Band VII, VIII., Frankfurt a. M., 1872.

(6) *Von Lendenfeld.* Zur Histologie der Actinien. Zoologischer Anzeiger. Band VI., Seite 189.

(7) *R. Hertwig.* Die Actinien der Challenger expedition. Jena., 1882, Tafel VI.

(8) *C. Claus.* Ueber Charybdea marsupials. Arbeiten aus dem Zoologischen Institute, Wien, 1878.

high development of the muscle in the Cœlenterata mentioned above, has as yet been described of the Hydroid-Polyps. I have however, been enabled to prove that such structures also occur in these least developed forms of all Cnidaria. The Hydroid-Polyps which produce the Sarsia radiata, V. Lendenfeld, have the peculiar habit of bending themselves down at a joint situated at the base of the Hydranth between it and the top of the Perisarc tube which surrounds the Hydrocaulus. This movement is executed with such precision and rapidity, that I was led to believe that there must be a special organ adapted for this purpose.

The Perisarc-tube of the Hydrocaulus terminates obliquly so that the margin has the shape of an oblique ellipse. In longitudinal and transverse sections even with a low power a bundle of longitudinal fibres can be detected, which is 0·5 mm. long and spindle-shaped. It covers that part of the supporting lamella which lays on the side of the Hydranths towards which it bends round. As well by means of osmic acid as by the application of warm solution of corosive sublimate (1) it is easy to kill the Polyps in different positions. If the re-agent does not act quickly, if it is too weak when it reaches the Hydranth, the latter always shuts up entirely and is fixed in this position. Bent down half the Polyps are never fixed, but it is very easy to harden the Polyps in an upright position. This muscle which I name Flexor is peculiar to Sarsia radiata, and no similar structure has, as far as I know, ever been observed in Hydroid-Polyps. We shall see that the histological structure is very different from the ordinary occurrence in the Hydro-Polyps. This structure reminds us of the complicated muscles of the free swimming

(1) *A. Weissman*, Die Entstehung der Sexuazellen bei den Hydromedusen. Iena., 1883, Seite 13.

Polypo-medusæ and Syphonophoræ. In an ordinary transverse-section a radial structure of this muscle can be detected. By means of very fine transverse sections we can obtain an insight into the minute structure.

From the structureless supporting lamella longitudinal supporting ridges rise up on the sides of which muscular fibres are situated. The free margins of these ridges are continued into the centripedal ends of the epithelial cells, which form the Ectodermal Epithelium. These are at the same time Chitin-gland cells; near the outer margin they appear slightly striped radially, and are continued into the substance of the cuticle or the Perisarc, according to whether the section has been made in a higher or a lower part.

The section, fig. 1, lies in the same height as that in fig. 4; the thin cuticule is cut.

In adult animals these cells are not entirely filled with Protoplasm attached by a broad basal surface to the inner surface of the Cuticle, these cells appear as pyramids with a radially situated axis. Centripetally their width rapidly decreased, and they continue without apparent limit into the margin of the supporting ridges. The space between the basal ends of these cells and between the opposite muscular lamellæ is taken up by a granulose mass in which nuclei can be made visible by coloring. A great many of these nuclei probably belong to the sub-epithelial muscular cells. Whether some of them belong to ganglia-cells appears doubtful, but I consider it nevertheless highly probable. Part of this mass probably also consists of nerve fibres. There are accordingly longitudinal bands of tissue which are vertical on the surface of the Hydranth. Between every pair of muscular bands lies a band, consisting of nervous fibres and ganglia cells. These are enclosed on the outer side by ordinary epithelial-cells.

Similar structures were first observed by Claus (1) in an Aphacella, and Brothers Hertwig (2) have independently described similar muscles in the Craspedote Medusæ. Identical structures are met with in Actiniæ, Acraspedæ and Pennatulidæ, although they vary very much, still we find that in so far they resemble one another, that the muscular cells principally cover the *lateral* surfaces of the supporting ridges, and do not occur on the free margins. Very often they are also wanting in the valley between the supporting ridges.

Although earlier observers did not take any notice of this fact, still it appears from the figures, that there are no muscles on the free margin of the supporting lamella. In all cases observed by me, the supporting ridges are very thin, the margin of them is continued into the epithelial cells, and I suppose that this pertains also in the cases mentioned above. In every case these muscular bands consist of striated band-shaped fibres as they were first described by Brücke (3.)

They are attached to a supporting lamella with a *narrow* side.

By these facts I have been led to the following explanation of these structures :—The epithelial cells are in connection with the supporting lamella by centrepetal processes. These processes are scattered irregularly over the originally plain surface of the supporting lamella. The muscular epithelial cells occupy the spaces between the stalks of the epithelial cells. If the supporting lamella forms folds so that a greater surface is attained to meet the exigencies of the increasing work that has to be done by the

(1) *C. Claus.* Ueber Haléstemma tergestinum. Arbeiten aus dem Zoologischen Institute. Wien 1878. Seite 8.

(2) *O. R. Hertwig.* Der Organismus der Medusen.

(3) *E. Brücke.* Ueber die mikroskopischen Elemente, welche den Schwimmuskel der Medusa aurita bilden. Sitzngber. A. K. Akademie der Wissenschaft, Wein. Band, XLVIII.

muscular layer, then the stalks of the epithelial cells move upward and finally occupy the ridges which have been formed, whilst the muscular cell adhering closely to the supporting lamella forms a continuous layer on the sides and at the bottom of the valley. The nervous elements which always lie above the muscular layer of course, then fill the part of the valley which has not been occupied by the muscular elements. In the case of the tentacles of some Actinæ indifferent tissue is formed between the muscular and nervous layers (1.)

Such structures, however, appear rare, and have, as far as I know, not been observed anywhere else. A muscle, such as that described above of Sarsia radiata, however, is a structure very similar to that in other Coelenterata; also here the same causes have produced the same effect independently of each other.

Explanation of Plate XXX.

Sarsia radiata.

Fig. 1.—Transverse section through the base of a Hydranth. L. Oc. I.

Fig. 2.—Three Hydranths in different positions.

a.—bent down half.

b.—erect.

c.—bent down quite.

Fig. 3.—Longitudinal section through the basal portion of the Hydranth along the plain in which the Hydranth bends. DD. Oc. I.

S. layer of Chitin in the Perisarc.

Fig. 4.—Transverse section through the base of the Hydranth. DD. Oc. I.

M. Musculus Flexor.

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(1) *Von Lendenfeld.* Zur Histologie der Actinien, Zoologisher Anzeiger. Band VI. Seite 189.